



Original article

Possible involvement of reusable towels in the high rate of *Bacillus* species-positive blood cultures in Japanese hospitals

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ABSTRACT

Background: A number of outbreaks caused by *Bacillus* species have been reported to date. Outbreaks reported in the last decade have predominantly arisen in Japanese hospitals.

Aim: To elucidate factors contributing to these real or pseudo outbreaks by *Bacillus* species, and to evaluate the rate of *Bacillus* species-positive blood culture samples in Japan.

Methods: A systematic review of the literature was performed. Reports including data on outbreaks caused by *Bacillus* species were searched for in PubMed, Google Scholar and Evidence-based Medicine BMJ from inception through 10 Aug 2014. Japanese nationwide data on bacteriological tests were collected from Japan Nosocomial Infections Surveillance. Regional bacteriological data for Akita prefecture were collected using the Akita Regional Network for Infection Monitoring/Control System.

Findings: Contamination of reusable towels was suspected as a cause for the high rate of *Bacillus*-positive blood cultures in Japan. The rate of *Bacillus* species in blood cultures was much higher in Japan than in reports from other countries.

Conclusions: The high contamination rate of blood culture samples by *Bacillus* species in Japan is a matter of concern for infection control and medical treatment. Bacteriological investigation of reusable towels should be considered in hospitals with a high frequency of *Bacillus*-positive blood cultures.

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1. Introduction

Bacillus species, including *Bacillus cereus*, are widely distributed in the environment. *Bacillus* species spores are resistant to heat, alcohol and other hospital disinfectants. *Bacillus* species identified in blood cultures are therefore usually considered as contaminations [1]. Contaminated bacteriological tests may lead to inappropriate diagnosis and therapy with unnecessary use of antimicrobials

and prolonged hospital stay. On the other hand, *Bacillus* species may cause serious infections such as sepsis and meningitis in immunocompromised patients. In the last decade, several outbreaks caused by *Bacillus* species have been identified in several hospitals in Japan [2–8]. The aim of this study was to evaluate the current status of outbreaks or pseudo-outbreaks caused by *Bacillus* species and to elucidate the contributing factors in these outbreaks. The aim of this study was to evaluate the current status of outbreaks and pseudo-outbreaks caused by *Bacillus* species and to elucidate factors contributing to these outbreaks. A pseudo-outbreak was defined as recovery of organisms in culture from a body site at a rate greater than expected, but not correlating clinically with the disease associated with the organism or the patient's disorder.

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2. Materials and methods

2.1. Ethics statement

This study was approved by the ethics committee at Hirosaki University Graduate School of Medicine (Approval number 2014-129).

2.2. Sources of data and literature search

Articles and reports were collected using Medical Subject Heading (MeSH) keywords “*Bacillus*”, “bacteremia”, “outbreak” and “blood culture” through PubMed and other search engines such as Google and Yahoo during the period from 7 Apr 2014 to 10 Aug 2014. The language was not restricted. Article selection was performed by two authors (H.K. and N.S) independently. Cases involving *B. anthrax* were excluded from this study (Fig. 1). To obtain the approximate rate of *Bacillus* species in blood cultures in Japan, data were collected from the Microbial Laboratory division of Japan Nosocomial Infections Surveillance (JANIS), a nationwide bacteriological test surveillance system with 928 participating hospitals, managed by the National Institute of Infectious Diseases of Japan. The seasonality of *Bacillus* species isolation from blood cultures was evaluated using the microbiological test results from 16 hospitals via RENICS [9], a regional microbiological information network in Akita prefecture.

2.3. Inclusion and exclusion criteria

All clinical reports on outbreaks caused by *Bacillus* species were included. Outbreaks caused by food poisoning were excluded. Studies were excluded if the causes of outbreaks were not clearly described.

2.4. Data extraction

The following characteristics were extracted from reported hospital outbreaks caused by *Bacillus* species: authors, nation, year

of outbreak, suspected source of the pathogen, and the season of the outbreak.

2.5. Statistical analysis

The rate of *Bacillus* species-positive blood culture samples was analyzed using chi-square test. A two sided p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using Microsoft Excel (Microsoft, Redmond, WA).

3. Results

3.1. Characteristics of *Bacillus* species outbreaks in hospitals

The published reports on outbreaks caused by *Bacillus* species are summarized in Table 1 [2,4,5,10–25]. Among the 23 reports collected, 18 were published in international journals, and 5 of those 18 reports were from Japan. Five additional reports were found, including four (No. 9, 10, 16, 17) in Japanese domestic journals and one (No. 22) on a website. All of these reports were from countries in the Northern Hemisphere. Suspected sources of contamination were reusable towels and linen (10 reports), ventilator circuitry and related instruments (4 reports), hospital rebuilding (3 reports), room air ventilating systems (2 reports) and others (5 reports). Outbreaks involving unusual causes, such as contaminations of ventilator airflow sensors, balloons used in manual ventilation, commercially available alcohol prep pads and blood culture analyzers, tended to have a long duration. *Bacillus* species were isolated from blood culture samples in 17 of the 23 reports, and in 9 of the 10 reports from Japan. Reusable towels and linen were the cause of outbreaks in 7 of the 10 reports from Japan. Continuous washing machines were usually used by outside laundries. To clarify the seasonality of outbreaks, the months involved in the outbreaks shown in Table 1 were accumulated and grouped according to causes of outbreaks (Fig. 2). Outbreaks caused by reusable towels and linen peaked in summer. Three outbreaks (No. 8, 10, 15) were excluded because no descriptions of seasons were provided. August was involved in 17 of the 19 outbreaks. Judging

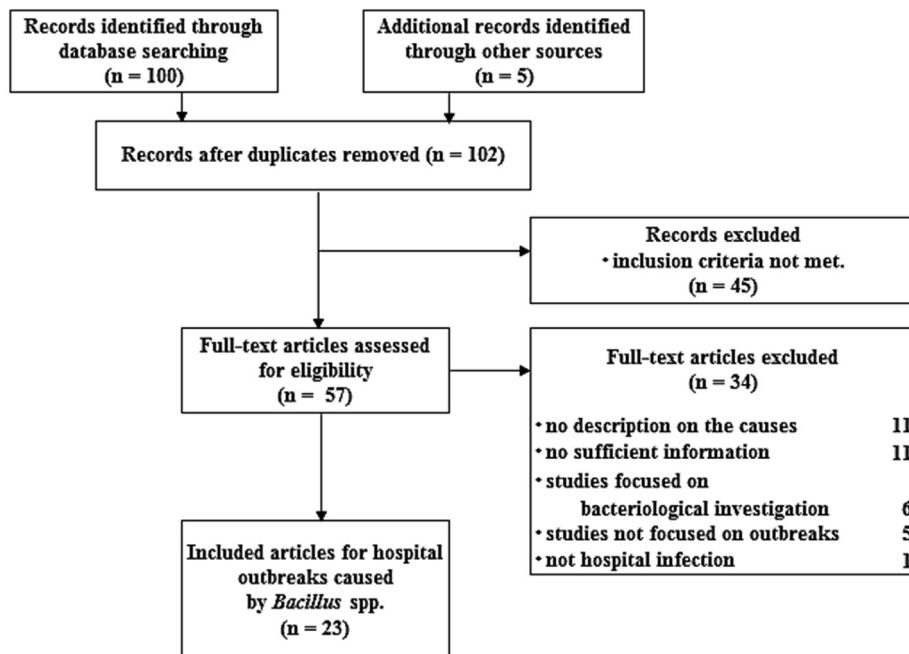


Fig. 1. Literature selection for *Bacillus* spp.-related hospital outbreaks.

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